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WANDERING STORMS

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Harvard University

Sir Napier Shaw, director of the British Meteorological Office and, during the war, scientific adviser on meteorology to the British Government, is now engaged with his colleagues in the preparation of a four-volume "Manual of Meteorology." Part I will give a general survey of the globe based upon the work of Hildebrandsson, Teisserenc de Bort, and others; Part II will deal with the physics of the air; Part III will contain a formal exposition of the thermics and dynamics with which modern meteorology deals; and Part IV, which has been issued in advance of the others[1] and is, in a way, a war product, discusses the relation of the wind to barometric pressure and the travel of cyclones. There were so many calls from insistent and impatient aviators that it was thought wise to attempt a general exposition of the probable paths of storms; the relation of surface wind to the so-called geostrophic wind, i.e. the component wind due to the rotation of the earth as distinguished from the cyclostrophic component due to the curvature of the path; the variation of wind with height; turbulence; gustiness; and cloud sheets.

Three Unusual Storms

As a frontispiece to the manual, Sir Napier Shaw uses three storm paths of unusual duration and remarkable recurvatures.[2] The details of these long-lived storms are given in Chapter 10 of the book, and we shall mention only a few facts connected with them.

The first storm is one of the typhoon, or *baguio*, type charted by the writer (Fig. 1). Detected first in latitude 15° N., longitude 148° E., in the western Pacific, on November 20, 1895, we can trace its wanderings halfway around the world. It reached the coast of British Columbia on January 12, 1896, and was stopped in its eastward course by an Alberta "high," or cold wave. Meanwhile the southern disturbance struck the coast of California at San Francisco on January 13 and presumably passed rapidly southeastward. In all probability the disturbance was over the valley of the Colorado on January 14 and merged in a large ill-defined depression following the advancing "high;" but we have not joined the storm centers, as definite data for this large area are lacking. That portion of the storm remaining over California worked its way slowly northward, with a tendency to recurve, but finally crossed the continent, well to the north, disappearing in the Hudson Bay section on January 20, 1896. If we assume that the southern storm preserved its identity, we find it moving steadily eastward, then northeast over the Atlantic, to disappear south of Iceland about January 22, 1896. This is the longest storm path and longest duration (64 days) yet recorded, but it is quite possible that other disturbances have lasted longer and traveled farther. This storm is also remarkable for the number of recurvatures. The resultant force which drives a cyclone eastward in temperate latitudes seems to have been reduced to a minimum several times in the storm's career.

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[1] Sir Napier Shaw: Manual of Meteorology, Part IV: The Relation of the Wind to the Distribution of Barometric Pressure. xvi and 166 pp.; maps, diagrs., ills., index. *M[eteorol]. O[ffice Publ. No]. 234.* Cambridge University Press, London, 1919. 12 s. 6 d. 10 x 7 inches.

[2] The detail with which these storm tracks are shown at sea may at first sight cause surprise. But the fact is that the network of weather-reporting ships, especially along the trade routes, is often as close as that of land stations in an area of the same size. The tracks shown are based upon data published by the Deutsche Seewarte of Hamburg, supplemented by U. S. Weather Bureau and U. S. Hydrographic Office reports.

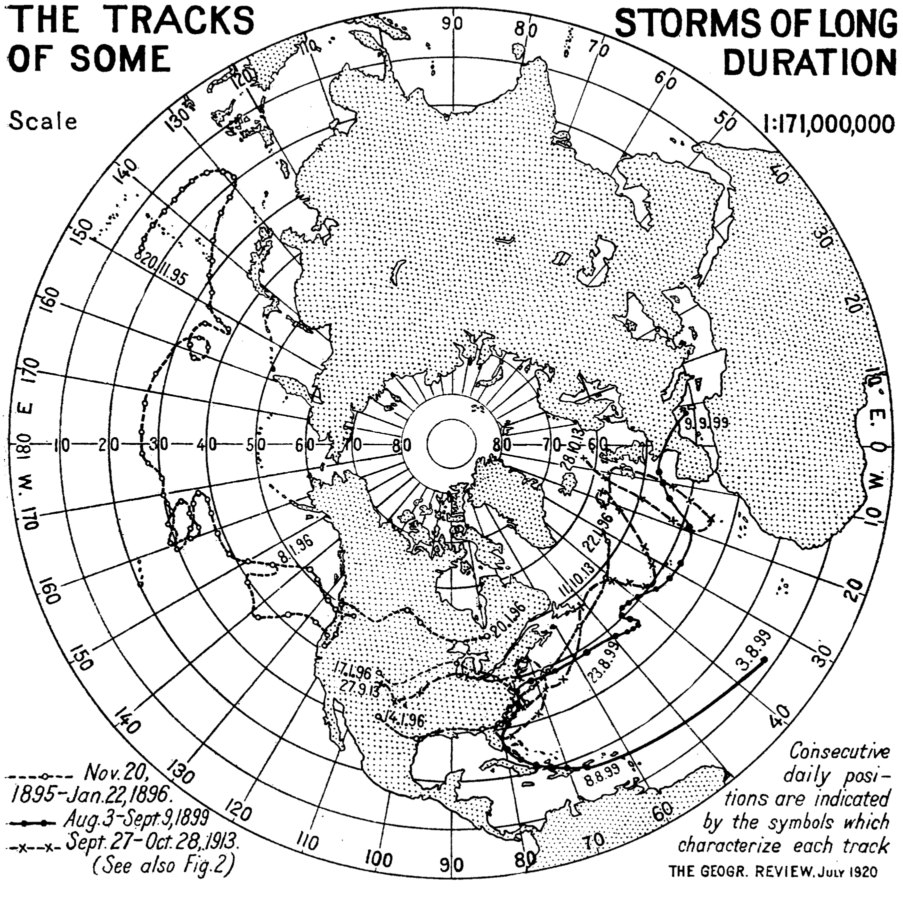
THE TRACKS OF SOME STORMS OF LONG DURATION
Scale 1:171,000,000
20.11.95
8.1.96
20.1.96
17.1.96
27.9.13
14.1.96
28.10.13
22.1.96
11.10.13
23.8.99
3.8.99
8.8.99
9.9.99
---o--- Nov. 20, 1895-Jan. 22, 1896.
—•—•— Aug. 3-Sept. 9, 1899
-x--x- Sept. 27-Oct. 28, 1913.
(See also Fig. 2)
Consecutive daily positions are indicated by the symbols which characterize each track
THE GEOGR. REVIEW, JULY 1920
E 170
180
W 170
10° E.
0
10 W.

FIG. 1—(Based on frontispiece of Sir Napier Shaw's "Manual of Meteorology, Part IV.")

The other storms are of shorter path and duration but of great interest, as they also show erratic paths (Fig. 1). The West Indian hurricane of August 3, 1899, detected in latitude 11° N. and longitude 35° W., recurved five days later off the Florida coast, journeyed leisurely northeast, reached the mid-

Atlantic twenty days after its first recognition, then halting, reversing, and doubling on its own track, finally moved east, passing over southern France on September 8–9 and thence rapidly southeastward across the Mediterranean.

The third storm, so far as can be now ascertained, developed near Great Salt Lake and disappeared near Lapland. Three recurvatures can be identified. After leaving the American continent on October 2, 1913, it pursued a most erratic course and was centered near Ireland on October 21. It then shot southward, missing Great Britain, and for four consecutive days moved at the rate of 600 kilometers per day, that is, 15 miles per hour. Doubling on its track it made an even more rapid and direct northing and passed over the Faroe Islands, headed for the Lapland coast. The path is so unusual and has such a bearing upon transatlantic steamship routes that we have plotted it, on a larger scale than that on which it is shown in Figure 1, on a map in Mercator's projection (Fig. 2). One can readily see how a storm like this nullifies the forecasts.

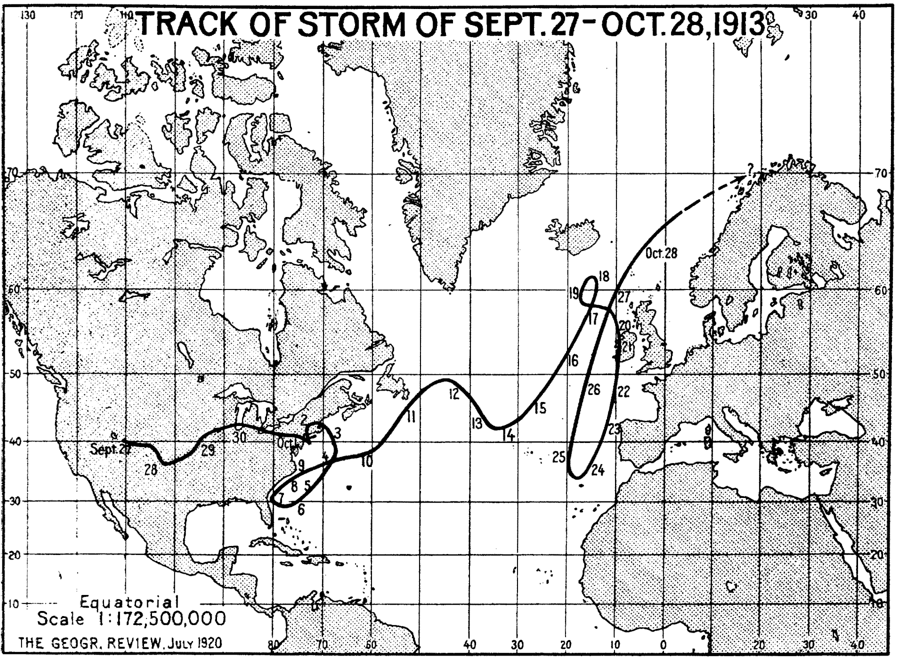

Fig. 2

Need of Accurate Aërographic Data for the Aviator as Illustrated by the Transatlantic Flights

Granted that transoceanic steamship traffic requires the fullest possible knowledge of storm tracks, how much more important are accurate aërographic data for airship movements! The airman who attempts a flight of even limited duration needs much information, while the long-distance flyer simply trifles with fate if he ascends in ignorance of what the map shows regarding the location, path, and structure of an approaching storm. In these days of long flights, like those between England and Australia and even the shorter transatlantic and transcontinental flights, the aviator must "lean, and lean heavily," upon the aërographer. I quote these words because they are the identical words used by Commander J. H. Towers, U. S. N., in charge of the transatlantic flight by the Navy-Curtiss seaplanes in May, 1919, when asking the writer to supervise the aërographic work connected with that flight.[3]

After leaving Rockaway, the first stop in the flight of the seaplanes was in Halifax harbor. Here, on the U. S. S. *Baltimore,* under Captain Cluverius, U. S. N., the writer established an aërographic observatory. More than one hundred observations of the usual surface conditions were made, supplemented by numerous pilot-balloon flights. Twice daily a weather map was drawn, based on extensive reports from the Weather Bureau. Similar work was done at the next station, Trepassey Bay, Newfoundland, and reports were received from a string of destroyers and some battleships, stretching to the Azores and on to Lisbon. The story of the struggle of the planes with wind and weather, fog and heavy seas has been graphically told by Westervelt, Richardson, and Read.[4]

Hardly was this transatlantic flight accomplished before Alcock and Brown in a swallow-like dart crossed without stop, in 16 hours, the 3,115 kilometers between Newfoundland and Ireland. *Favorable northwest to southwest winds made the flight possible.* By the first of July, the big British dirigible R34 was ready and made the trip westward in 108 hours. All that modern science could do to aid was done, and her return passage, made in 75 hours, illustrates well the value of a knowledge of storm location and path. What Commodore Maury accomplished for the clipper ships of his day, the British and American aërographers did for the airships of July, 1919.

Need in Forecasting of Knowledge of Recurving Storms

So the forecaster of today must be on the alert to detect any tendency of the passing storm to recurve. Most storms travel on anticipated paths, though the velocities may vary from ten to forty miles an hour. Sometimes a storm will cross the Atlantic in three days, and again, as we have seen, some require weeks. Some never get across. Of this last class, the most remarkable illustration in a collection of erratic transatlantic storms covering a period of ten years is, in the judgment of the writer, that of May 8 to June 6, 1910.

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[3] Cf. the note "The Meteorological Aspects of the Recent Transatlantic Flights," *Geogr. Rev.*, Vol. 7, 1919, pp. 419-421.

[4] The Triumph of the N C's, Doubleday, Page & Co., New York, 1920.

This storm (Fig. 3) well deserves the name "cyclone," if the term is used in the sense in which Piddington, who coined the word, first used it, namely, the coils of a serpent, for it twists and turns upon itself. We have tracked it from the Strait of Juan de Fuca to the Grand Banks, whence it recurved again and again and came back to the continent on May 26. Here it met and merged with a storm that was moving north from Texas; and the new combination moved slowly east over Nova Scotia. Notwithstanding this increase of storm energy, the forces compelling a northerly direction—strong south winds due to a marked North Atlantic hyperbar—still prevented progress east; and for more than ten days, until June 7, this "low" remained practically stationary southeast and east of Nova Scotia, dissipating in showers and thunderstorms. In the history of a storm like this will be found eventually the solution of the problem of accurate seasonal forecasting.

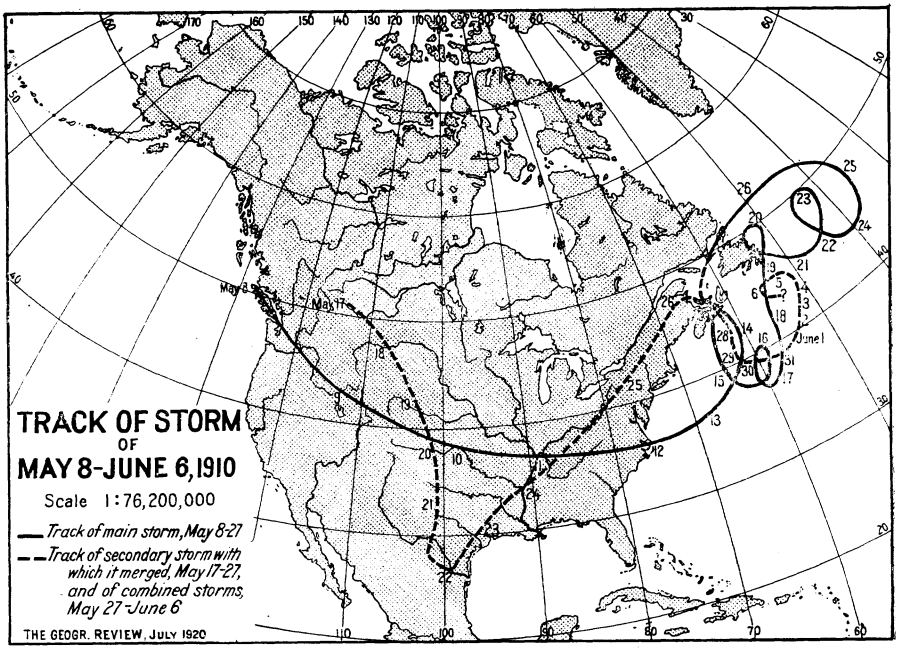
TRACK OF STORM
OF
MAY 8-JUNE 6, 1910
Scale 1:76,200,000
Track of main storm, May 8-27
Track of secondary storm with which it merged, May 17-27, and of combined storms, May 27-June 6
THE GEOGR. REVIEW, JULY 1920
May 8
May 17
June 1

Fig. 3

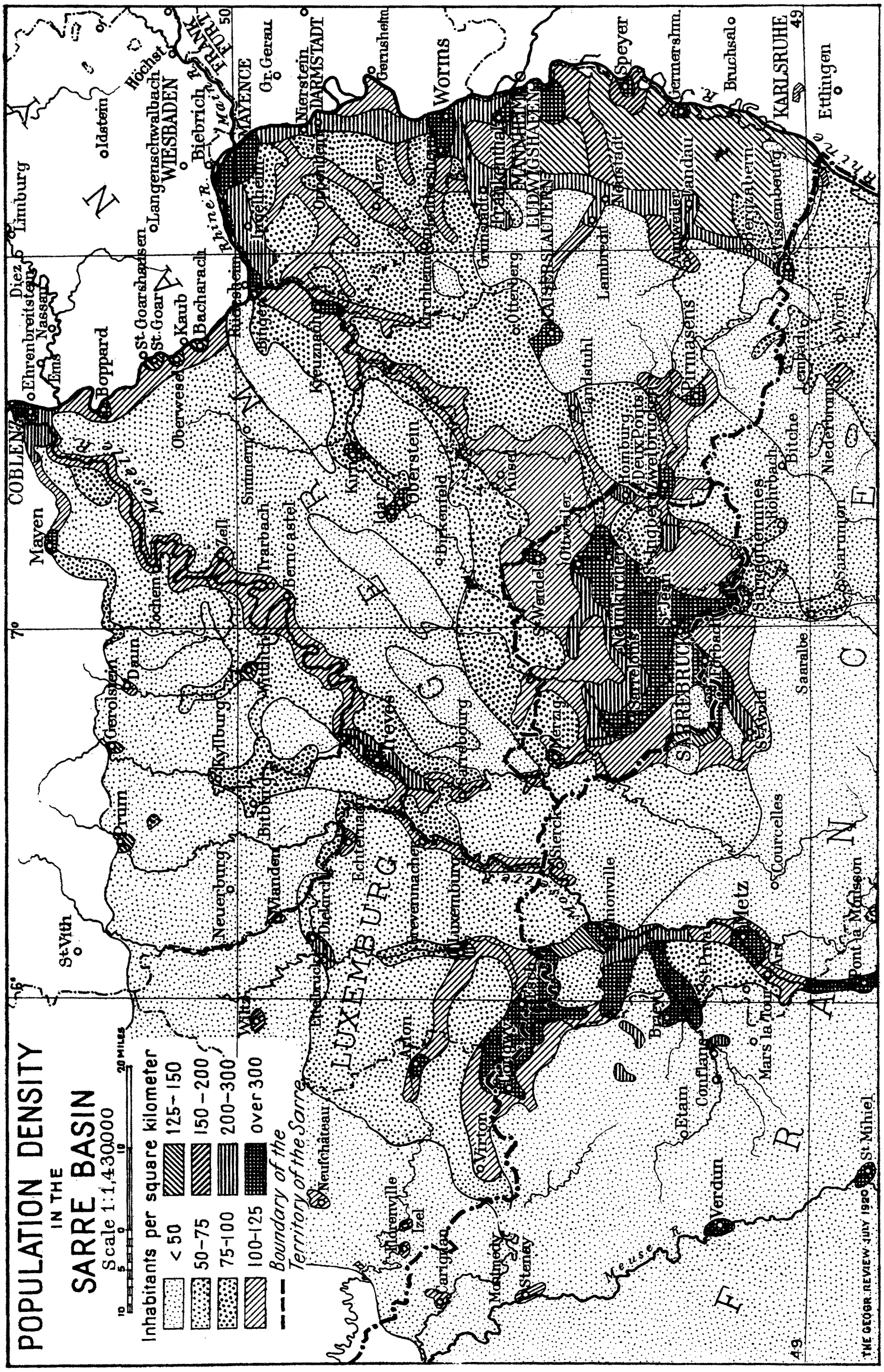
POPULATION DENSITY
IN THE
SARRE BASIN
Scale 1:1,430,000
10 5 0 10 20 MILES
Inhabitants per square kilometer
< 50
50-75
75-100
100-125
125-150
150-200
200-300
over 300
Boundary of the Territory of the Sarre
THE GEOGR. REVIEW JULY 1920
COBLENZ
MAYENCE
WIESBADEN
DARMSTADT
Worms
MANNHEIM
LUDWIGSHAFEN
KAISERSLAUTERN
Speyer
Landau
KARLSRUHE
Kreuznach
Birkenfeld
Treves
SARREBRUCK
St. Jean
Neunkirchen
Saarlouis
St. Wendel
Homburg
Deux Ponts
Pirmasens
Bitche
Saargemünd
Sarreguemines
St. Avold
LUXEMBURG
Luxemburg
Arlon
Thionville
Metz
Pont à Mousson
Verdun
St. Mihiel
Longwy
Briey
Conflans
Mars la Tour
Étain
Virton
Montmédy
Stenay
Carignan
Sedan
Neufchâteau
Bastogne
Wiltz
Diekirch
Echternach
Bitburg
Prüm
St. Vith
Neuerburg
Kyllburg
Gerolstein
Daun
Cochem
Mayen
Zell
Trarbach
Bernkastel
Simmern
Oberwesel
Boppard
Bacharach
Bingen
Rüdesheim
Kaub
St. Goar
Ems
Diez
Nassau
Limburg
Idstein
Höchst
Biebrich
Ingelheim
Oppenheim
Alzey
Kirchheimbolanden
Frankenthal
Grünstadt
Neustadt
Germersheim
Bruchsal
Ettlingen
Bergzabern
Weissenburg
Wörth
Niederbronn
Lembach
Landstuhl
Lambrecht
Otterberg
Kusel
Oberstein
Idar
Kirn
Saarburg
Merzig
Sierck
Remich
Grevenmacher
Courcelles
Saaralbe
Saarunion
Rohrbach
Zweibrücken
St. Ingbert
Ottweiler
Mosel R.
Rhine R.
Main R.
Meuse R.
Sarre R.
N
E
F
R
A
C
U
G
50
49
7°
6°

Fig. 1